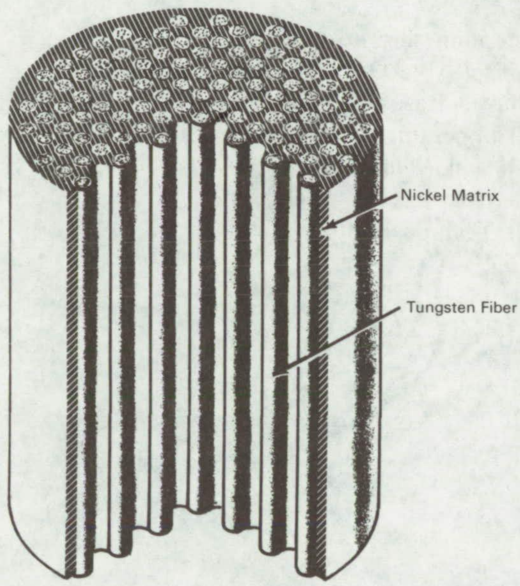
NASA TECH BRIEF

Tungsten Fiber-Reinforced Nickel Superalloy



Fiber reinforcement of metals has been investigated intensely in recent years. One of the promising fiber composite types being studied is refractory metal fiber-reinforced superalloys. This type of material has the potential of combining the strength of refractory metals with the oxidation resistance of superalloys.

Extensive studies of model-system fiber composites have shown the excellent potential of fiber-reinforced materials, provided that the strength of fibers could be retained (fiber-matrix reactions can seriously reduce composite strength). In the present work, knowledge of the relationship between fabrication techniques, matrix compositions, and fiber sizes was used to minimize fiber-matrix reaction, thus limiting the reduction of composite properties. This current research has also evolved a generally applicable method for further composite material development. The success in obtaining good composite strength retention for high temperature exposure indicates that fiber-matrix reactions can be overcome for metal fiber-metal matrix composites. The tungsten fiber-reinforced nickel-base superalloy developed has excellent stress rupture strength at temperatures of 2000° to 2200° F. The matrix composition in weight percent is: nickel 56, tungsten 25, chromium 15, titanium 2, and aluminum 2. The fiber composition is tungsten with 1 wt. % thorium oxide. The composite is prepared by slip-casting a matrix powder–water slurry into an array of fibers. The dried slip-casting is consolidated by pressirg and heating. Fiber contents can be varied from 0 to 80 volume percent to achieve the desired reinforcement. The 70 volume

percent unidirectional fiber composite has a 26,000 psi stress for rupture in 1000 hours at 2000° F. This is four times as strong as commercially available nickel superalloys. The composite may also be used where weight savings are desirable since it is twice as strong as competing superalloys on a stress-density basis.

The fiber composite may be substituted for superalloys where higher strength or greater strength to density ratios are beneficial and will permit higher use temperatures for particular applications. Examples of potential applications include high temperature turbine components, such as buckets and vanes, coolant tubes, and turbine generator components for advanced electrical power systems.

Notes:

1. Further information concerning this invention is presented in NASA Technical Note D-4787, "Refractory Metal Fiber Nickel Base Alloy Composites for Use at High Temperatures" (formerly published as NASA Technical Memorandum X-52342), which is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.
2. Single copies of Technical Note D-4787 may also be requested from:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B68-10369

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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